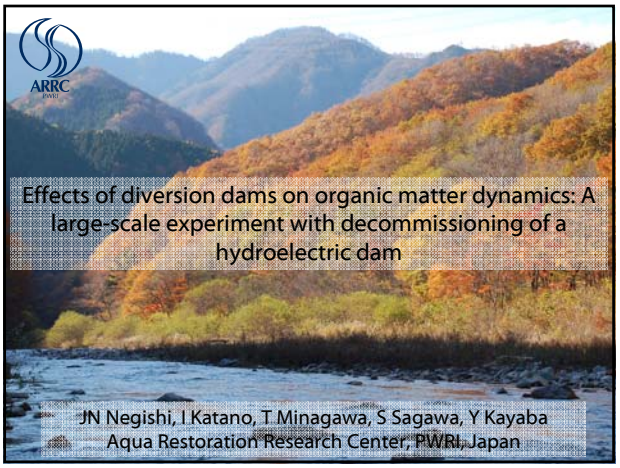

Effects of diversion dams on organic matter dynamics: A large-scale experiment with decommissioning of a hydroelectric dam

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Dam decommissioning (complete dismantling or removal of structures not implied):

- It means to physically render a dam incapable of impounding any significant quantity of water (*Nevada Administrative Code*)
- This option alters the dam structure, restores flow, and permanently changes the dam's original function (*River Recovery, BC, Canada*)

Understanding of the effects of dam decommissioning is limited

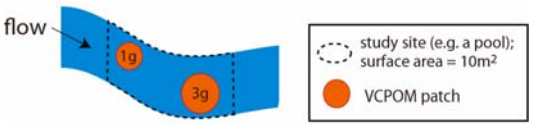
Effects of dams:

- Changes in physical environments
  - Flow regime
  - Sediment regime
  - Water chemistry
  - Substrate characteristics…
- Responses of biological communities
  - Macroinvertebrates
  - Fish
  - Periphyton…

Relatively little is known for coarse organic matter dynamics; process-based empirical understanding is scarce

- To examine how decommissioning of a hydroelectric dam affects flow regimes and dynamics of very coarse particulate organic matter (VCPOM, leaf detritus, > 1cm)
  - VCPOM dynamics: *leaf litter input, drift flux, transport distance, benthic mass (total dry mass & unit-area dry mass)*

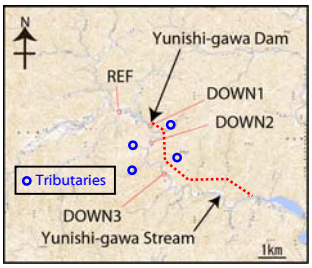
Backgrounds Objectives Methods Results Summary



- total benthic mass = 1 g + 3 g = 4 g
  - total food resource abundance for shredders
- unit-area benthic mass = 4 g / 10 m^2 = 0.4 g/m^2
  - quality of habitat for shredders

Backgrounds Objectives Methods Results Summary

- A 8-km-long stretch of 5th-order Yunishi-gawa Stream
- 1 in upstream and 3 in downstream areas of the dam
  - Referred to as *study stations*
- Tributary inflow progressively attenuated the dam effect
- Annual precipitation of 1,800mm
- Altitude of 650~730m a.s.l.
- Riparian vegetation dominated by deciduous species (e.g. oak, maple, cherry, alder)
- Drainage area of ~150km^2



Backgrounds Objectives Methods Results Summary

- To examine how decommissioning of a hydroelectric dam affects flow regimes and dynamics of very coarse particulate organic matter (VCPOM, leaf detritus, > 1cm)
  - VCPOM dynamics: *leaf litter input, drift flux, transport distance, benthic mass (total dry mass & unit-area dry mass)*
- To test whether benthic VCPOM mass in geomorphic units (i.e. pools and riffles) differ in responses to the dam decommissioning
- To provide insights into how hydroelectric dams could alter VCPOM dynamics

Backgrounds Objectives Methods Results Summary

Yunishi-gawa Dam

- Completed in 1960 with an impoundment capacity of 80,000m^2
- Approximately 95% of base-flow diverted for power generation during non-flood periods
- Migration barrier for biota, discontinuity of sediment & OM
- Decommissioned on Sept 30, 2006 with the structure intact but gates fully open
- Sept 2006 (pre-data) and Sept and Oct 2007 (post-data) collected

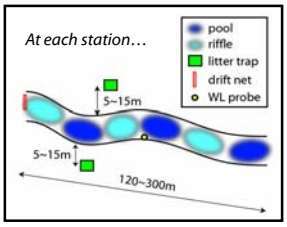
Backgrounds Objectives Methods Results Summary

- Flow regime
  - flow discharge (*WL continuously monitored + H-Q*)
- VCPOM dynamics
  - leaf litter input (*3 times in each yr*)

litter trap made of mosquito nets

  - drift flux (*3 times in each yr*)

drift net made of chiken wire (1cm mesh)

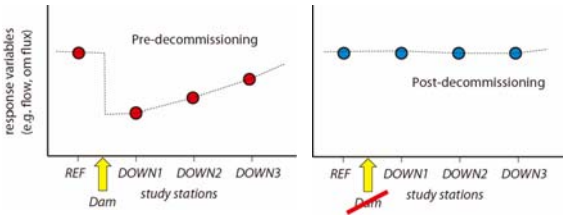


  - benthic mass (*once in each yr, 3 riffle-pool pairs*)

benthic VCPOM estimated using qudrates of various sizes

Backgrounds Objectives Methods Results Summary

Predictions

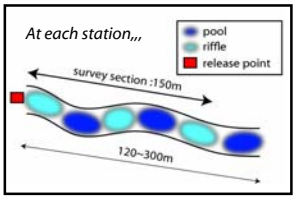


- 2-way ANOVAs with "year (dam decommissioning)" and "site (study station)" as main factors; a statistical term of interest was the interaction between two factors

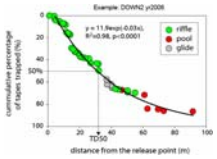
Backgrounds Objectives Methods Results Summary

- VCPOM dynamics
  - transport distance (*3 times in each yr*)

release of biodegradable flagging tapes (200 pieces)

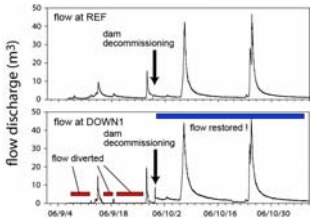


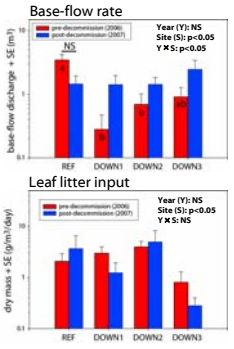
  - 3hrs after the release of tapes, trapped tapes located, counted, and recorded for the distance from release point and habitat types (pool or riffle)



Backgrounds Objectives Methods Results Summary

Flow regime & leaf litter input

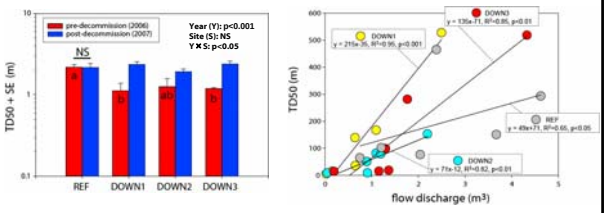




- Flow regime restored
- Leaf litter input similar across years; VCPOM dynamics expected similar without decommissioning effects

Backgrounds Objectives Methods Results Summary

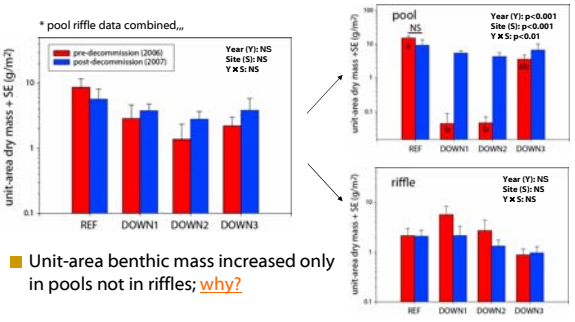
Transport distance



- Transport distance increased due to increased flow rates (source areas of VCPOM expanded)

Backgrounds Objectives Methods Results Summary

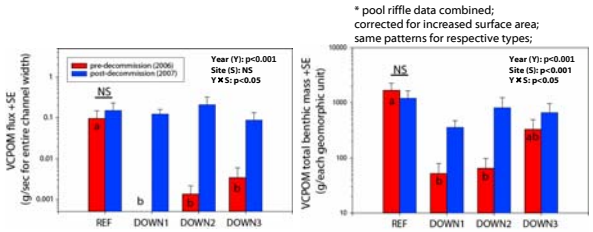
Unit-area benthic mass & habitat types



- Unit-area benthic mass increased only in pools not in riffles; why?

Backgrounds Objectives Methods Results Summary

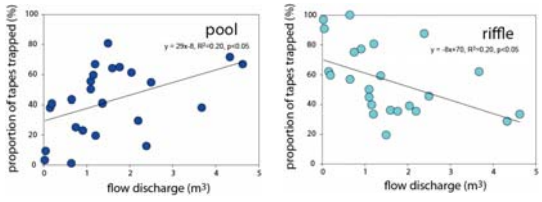
Drift flux & total benthic mass



- Drift flux and benthic mass increased due to removal of VCPOM sink (dam impoundment) and expansion of source areas

Backgrounds Objectives Methods Results Summary

Geomorphic units & retention efficiency



- Relative retention efficiency of riffles decreased with increasing flow compared to that in pools

Backgrounds Objectives Methods Results Summary

- Decommissioning of the hydroelectric dam…
  - Restored flow regime
  - Increased transport distance
  - Increased drift flux
  - Increased total benthic mass
  - Increased unit-area benthic mass only in pools
- Constructing hydroelectric dams likely to…
  - Reduce base-flow discharge
  - Shorten transport distance
  - Decrease drift flux
  - Decrease total benthic mass
  - Reduce unit-area benthic mass only in pools

Backgrounds Objectives Methods Results Summary

- Consequences of altered VCPOM dynamics?
  - Macroinvertebrate productivity and diversity (?) expected to positively respond to dam decommissioning (as the total mass = "food resource quantity" increased)
  - From the unit-area mass = "habitat quality" perspective, responses of macroinvertebrates likely depend on habitat-specific productivity (e.g. pool>riffle or riffle>pool)
  - Preliminary results on macroinvertebrates suggest pools more productive than riffles; the dam decommissioning likely had disproportionately positive effects on pool communities

    - Responses may vary depending on habitat-specific productivity and retention characteristics